Monochromators at Synchrotron SOLEIL

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SOLEIL SYNCHROTRON

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This poster presents a general overview of the different monochromators in operation at Synchrotron SOLEIL. These monochromators cover a wide energy range which starts from the low energies with few eV to the high energies reaching 50keV in.
The high energies are selected by the help of common monochromator crystals like Channel-cuts or Double Crystal Monochromators (DCM). Some of them are water cooled, others are cryocooled by LN2.
Some low energy monochromators are constituted of up to five interchangeable gratings while others high energy monochromators are equipped with 2 sets of crystals for example with one pair of silicon (111) crystals and another one pair of silicon (311).
The second crystal of the DCM should be a sagittal focusing crystal.
In addition, one beamline is equipped with a Quick EXAFs monochromator with adjustable amplitude of oscillations and a variable frequency.

Low Energy Monochromator

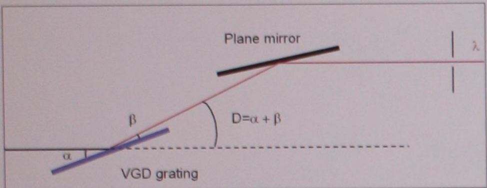
The low energies are selected by the help of plane grating like the usual type with Variable Line Spacing - Variable Groove Depth (VLS-VGD) along the grating lines and the "multilayer" grating. Some low energy monochromators are constituted of up to five interchangeable gratings.

The CASSIOPEE plane grating monochromator - 10 to 1500eV

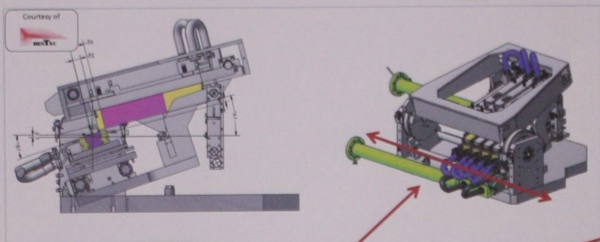
The CASSIOPEE plane grating monochromator was designed by the SOLEIL Optics Group.

The working principle of the monochromator is sketched in the figure below. One can choose the incident angle α of the white beam on the plane grating by rotating the grating around an horizontal axis. The β angle can be chosen by rotating the plane mirror, above the grating, around a horizontal axis located below the grating plane, to ensure a constant height of the outgoing beam. The CASSIOPEE monochromator contains three different gratings with 400 l/mm, 800 l/mm and 1600 l/mm respectively.

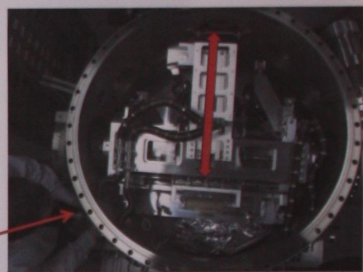
The CASSIOPEE monochromator is designed to work in the "modified Petersen mode", which means that α and β are always chosen to fulfill $\frac{\sin\beta}{\sin\alpha} = c \approx 0.2$ to ensure an optimal resolution on the whole photon energy.



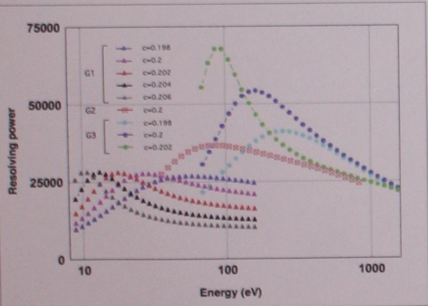
Working principle of the Plane Grating Monochromator



Hermes - low energy monochromator



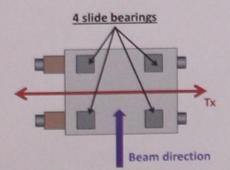
Cassiopee - low energy monochromator – Top view



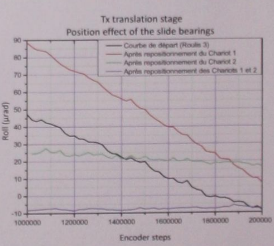
Cassiopee - Figure of the C factor; resolving power vs Energy

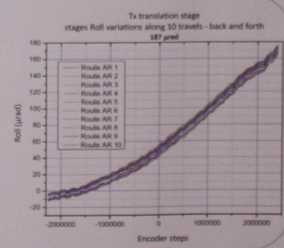
ANTARES - low energy monochromator – Tx Translation stage

Tx translation stage



The positions and the fixations of the slide bearings have a important influence on the quality off the roll of this stage as illustrated in the figure to the side.



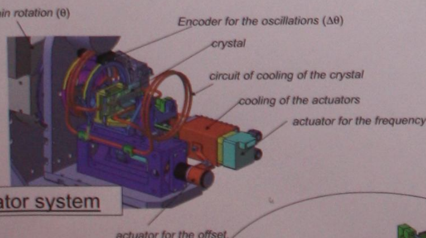


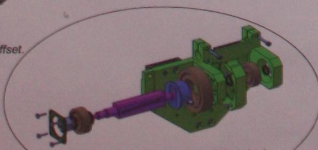
High Energy Monochromator

SAMBA Beamline _ Quick-EXAFS monochromator - *energy range → BM / 4 to 40keV*

Adjustable Oscillator from the outside of the vacuum vessel

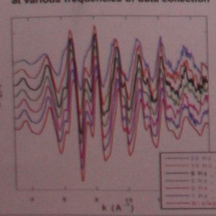
This design concerns the possibility to adjust the oscillation amplitude without opening the vessel, in other words at most several minutes during an experiment. Then the device permits to control the angular position of the crystals on the fly .
The oscillator moves a channel-cut crystal from a frequency of 0.1 hertz on a range ±2° to a frequency of 50 hertz on a range ±0.1°.





Details of the variable cam (exploded view)

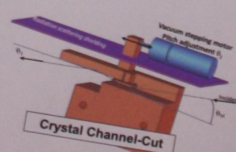
Single Quick Scan Nickel foil compared to step by step scan at various frequencies of data collection



Data quality is stable with frequency and no systematic error is introduced by the device as compared to a spectrum obtaind step by step with another monochromator on the same Ni foil on the same beamline.
The only drawback is a poorer resolution beyond 10Hz inherent to the frequency cutoff of the employed detectors (ionization chambers).

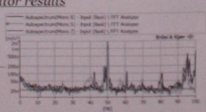
Proxima 1 Beamline _ Channel-Cut monochromator

- *energy range → ID / 5 to 15keV*

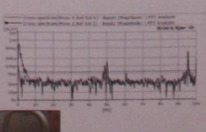


PROXIMA 1 Monochromator results

The crystal of the PX1 monochromator is equipped with a tri-axial accelerometer mounted directly on its support. The structure of the monochromator is designed to absorb much of the vibrations induced by external excitations. The top graph shows the vibration spectra in the S, X & Z directions. Note ~~that there are no strong vibrations below 40Hz~~ and that the structure of the monochromator is able to absorb much of the external vibrations. In previous work (MEDSI2008, CLS) we demonstrated that the majority of the harmonics measured are excited by the swing of the ion pump under the monochromator chamber. This vibration mode near 48Hz can still be observed on the crystal of the monochromator.



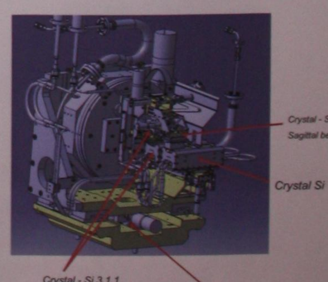
The graph on the bottom displays the transfer function between the reference spectra on the floor and the crystal spectra in X & Z directions. In both the X & Z directions, the first resonances transmitted to the crystal are near 48 – 50 Hz, and another resonance can be seen near 61 & 95 Hz.



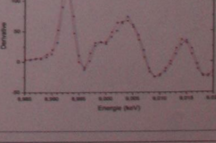
Proxima 1 - Monochromator mechanism under construction

CRISTAL Beamline _ double DCM monochromator

- *energy range → ID / 4 to 30keV*



the derivatives of repeated spectra measured along 4 days, show a 0.5 eV reproducibility in energy (5 10^{-5}). However, additional measurements have shown that after a long beam loss or a large angular displacements of the DCM, the reproducibility could deteriorate down to DE/E = 10^{-3}, requiring an energy re-calibration if accuracy is needed.



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